IIT KHARAGPUR

INTER IIT TECH MEET 10.0

25-27TH MARCH 2022

BLUE YONDER'S NEXT-GEN OPTIMIZED DELIVERY ECOSYSTEM

Automation in delivery system is a budding area of research and engineering. With the advent of drones, the requirement of hardware for such a system is well-supported, but to make this an implementable idea in mass, we need to have a sustainable ecosystem where we provide a drone deployment plan along with flight path and routing details while servicing the customers at the lowest possible cost.

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PROBLEM STATEMENT

DESCRIPTION

Acme E-Com Inc (referred to as 'Acme' henceforth), is a successful e-commerce corporation. It has an efficient last-mile road network to deliver its products to the customers from its many warehouses. As part of their future-readiness initiative, Acme wants to incorporate automated drones as part of their fleet for these last-mile deliveries. Acme wants to pilot this approach in the city of 'Dronapur'.

To optimize its drone fleet and plan its drone delivery operations, Acme has engaged a trustworthy partner – You. Your objective is to design and create a solution that can provide a drone deployment plan along with flight path and routing details while servicing the customers at the lowest possible cost to Acme.

PROBLEM STATEMENT

Provide a cost-optimal deployment plan and routing plan for the available drones for the given set of delivery points in 3-dimensions. The constraints and complexities are:

Base Problem

Acme has a single drone-ready warehouse at coordinates (0, 0, 0) which will serve as the base for drone delivery operations. Acme has visibility to planned deliveries from today + 2 days and the corresponding coordinates in three dimensions with respect to the warehouse. The warehouse has an unlimited number of drone charging bays.

Drones come in several varieties with different attributes like cost, maximum speed, speed profiles, payload capacity – weight, cubic & slots, energy profiles, etc.

Drones start their day at 08:00 AM from the warehouse on Day 1, with one or more items in their slots and follow a defined path to the demand location(s). After a delivery, a drone may deliver to the next customer or return to the warehouse for charging.

Energy is consumed in form of battery for various drone operations. In general, bigger drones have bigger battery and can carry more payloads, but their energy usage is correspondingly high. Energy also contributes to the cost of operation and hence needs to be minimized.

Recharge Stations: Acme has decided to install dedicated recharge stations at different points where drones can recharge their batteries to enable longer ranges and more optimal delivery strategies. Each recharge station, however, has limited bays for the drones and different charging times for each drone.

Complexity #1: No-Fly Zones

The city council of 'Dronapur' has prohibited the movement of drones in certain areas. This could be due to high population density, high traffic, or secure government facilities. This will be provided as a set of No-Fly 'cuboids' with all coordinates.

Complexity #2: Multiple warehouses

With the success of the drone-based deliveries, Acme decides to open 2 more warehouses in the satellite suburbs of 'Dronapur'. Drones can start from one warehouse and travel to another one during the day. At the end of the day, the drones can come back to any of the warehouses and start the next day from there.

Complexity #3: Dynamic Replanning [BONUS]

Acme's customers can possibly refuse to take the delivery of the item when the drone reaches the location, due to various reasons. This typically happens for 2% of the cases. The refusal not only leads to replanning for the individual drone but can have a domino effect on the entire plan for the day.

OBJECTIVES

OBJECTIVE PRIORITY #1: Fulfill maximum possible demand. A solution serving less than 95% of the demand will be deemed 'invalid'.
OBJECTIVE PRIORITY #2: Minimize total cost.
Cost components to be captured are:
a. Energy Cost
b. Maintenance Fixed Cost
c. Maintenance Variable Cost

OBJECTIVE PRIORITY #3: Minimize the number of drones used on any day.

DATA

The input data will be across multiple CSV text files with a predefined schema. The data format and sample will be provided to the team. This can be used to build and test the model.
The drone optimization instructions and table formats along with the sample input and output files have been attached here.

EVALUATION

The teams will be required to run their model with up to 5 test scenarios that will be provided at the time of final submission. Performance on these scenarios will be used for the final evaluation.

The teams will be ranked on the basis of the following criterion:
The higher priority criterion is more important. E.g., a team achieving higher 'Demand Met' will score higher than another team that is delivering lower 'Total Cost'.

1. Demand Met
2. Total Cost (ref Objective #2 for cost components)
3. Number of drones in play
4. Model Performance on time taken for the solution.

SCORING

The points will be decided on the basis of:

A. Solution validity [Max 100 points]

Teams will receive guaranteed minimum points for a **valid** solution regardless of the ranking:

1. Base Problem without any complexity: [50 Points]
2. Complexity#1: [30 Points]
3. Complexity#2: [20 Points]
4. **[Bonus]** Complexity#3: [Bonus points will be announced later]

B. Relative ranking between the teams [Max 50 points]

Refer to section 'Evaluation' for ranking rules. Based on the number of submissions and ranking, teams may get points ranging from 5-50.
Participants must solve complexities **only in the given order.**
E.g., A team may choose to attempt Base Problem + Complexity 1 for a max total of 80 points.
However, they may not do Base Problem + Complexity 2 (as it skips over Complexity#1)

GUIDELINES

Participants need to follow the following submission guidelines :

1. Clearly mention the outputs belong to which scenarios.
2. The complexity which is being attempted for an output should be mentioned (Base or Base + 1 or Base + 1 + 2).
3. In case complexity 3 is being attempted, 1A will be the original plan and 1B will be the re-plan after cancellation
4. Mention all the assumptions which the team undertook with proper justification.

5. By 20th March IST midnight, the additional input scenarios would be provided (3 to 5 Scenarios)

SUBMISSION

Teams have to submit the output in the prescribed format and the code with proper documentation in GitHub and send the repository link to the email id mentioned below.

DEADLINE - 23:59, 23rd March 2022.
Send your submissions at this email: submissions@interiit-tech.org

Team size for this event is maximum 5 participants.
Participation awards shall be awarded to all participants.